

## Earth's Atmosphere

### ES-4 The student will demonstrate an understanding of the dynamics of Earth's atmosphere.

#### ES-4.7 Summarize the evidence for the likely impact of human activities on the atmosphere (including ozone holes, greenhouse gases, acid rain, and photochemical smog).

**Taxonomy level:** 2.4-B Understand Conceptual Knowledge

**Previous/future knowledge:** Students have not been introduced to the concepts in this indicator in any previous grade.

**It is essential for students to know** that human activities have an impact on Earth's atmosphere. Global atmospheric effects include ozone depletion, global warming, acid precipitation, and air pollution, such as photochemical smog, ozone, and particulate matter.

#### ***Ozone depletion***

Ozone depletion results from human activity through the use of chlorofluorocarbons (CFCs).

- CFCs are stable and harmless near Earth's surface but when they move into the upper atmosphere, they destroy ozone molecules that protect Earth from harmful ultraviolet radiation.
- Since the mid-1980s studies of the atmosphere have detected a thinning of Earth's protective ozone layer, most dramatically over Antarctica, called the "ozone hole".
- Because all CFCs released into the atmosphere are from man-made products, ozone depletion is entirely the result of human activity.

#### ***Global warming***

Global warming is natural for Earth's atmosphere to trap heat in the troposphere; this is known as the *greenhouse effect*.

- Global warming is the increase in Earth's average surface temperature.
- This is partly caused by human activities especially the burning of fossil fuels that significantly increases amounts of carbon dioxide, a main *greenhouse gas*, released into the atmosphere.
- Carbon dioxide absorbs heat very readily. Increases in amount of carbon dioxide will intensify the greenhouse effect and may cause Earth to become warmer.
- The presence of other gases such as methane and CFCs also has an effect on the warming of the atmosphere. Much of the methane and all of the CFCs were put into the atmosphere by human activity.
- Increases in global temperatures can have dramatic effects, such as changes in agricultural belts, glacier-ice cap melting resulting in rise in sea level, and difficulty of certain plants and animals to adapt resulting in extinction.

#### ***Acid precipitation***

Acid precipitation, or *acid rain*, is defined as precipitation with a pH of less than 5.0.

- Natural precipitation has a pH of about 5.0 to 5.6, which is slightly acidic.
- Sulfuric and nitric acid results when precipitation combines with sulfur dioxide and nitrogen oxides in the atmosphere.
  - Sulfur dioxide is produced primarily by burning fossil fuels such as coal that contains sulfur.
  - Nitrogen dioxide is produced by the high temperatures and pressures that exist inside internal combustion engines such as those in automobiles.
- These acids can be carried by winds long distances, thereby affecting areas far from their source.
- When acid precipitation makes its way into water bodies, it causes damage to the aquatic ecosystems and vegetation. It can affect plants and soil. Acid rain also damages stone buildings, statues, and even metal structures accelerating the processes of weathering and corrosion.

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### ***Air pollution***

The air near Earth's surface can become polluted several ways.

- *Photochemical smog*, a yellow-brown haze in the air, is caused by the action of solar radiation on an atmosphere polluted with hydrocarbons and nitrogen oxides, mostly from automobile exhaust systems. The air becomes harmful to breathe.
- A major chemical in smog is *ozone* – in the upper atmosphere it is beneficial, but near the surface it is a pollutant. Ozone irritates the eyes, nose, and lungs of humans and is also harmful to plants.
- Air pollution also occurs when *particulate matter*, such as carbon ash, dust, pollen, or asbestos fibers accumulate in the atmosphere. These particles are breathed in and lodge in the nose and lungs disrupting normal functions.

**It is not essential for students to know** the chemistry behind the formation of these types of pollution. They do not need to complete acid/base/neutralization reactions; although taking pH readings from water or soil samples might help in the summary. Even though this human impact leads to the need for reducing air pollution, that would be an interesting discussion but not essential to this indicator.

### **Assessment Guidelines:**

The objective of this indicator is to *summarize* the evidence for human impact on the atmosphere; therefore, the primary focus of assessment should be to generalize major points about the ways that human activity has resulted in changes in Earth's atmosphere.

In addition to *summarize* appropriate assessments may require students to:

- *compare* these various types of atmospheric effects;
- *compare* the types and sources of air pollution;
- *identify* the causes of these impacts on the atmosphere; or
- *recall* the effects that these impacts can have on human beings and the environment.